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Cough Activated Dynamic Face Visor

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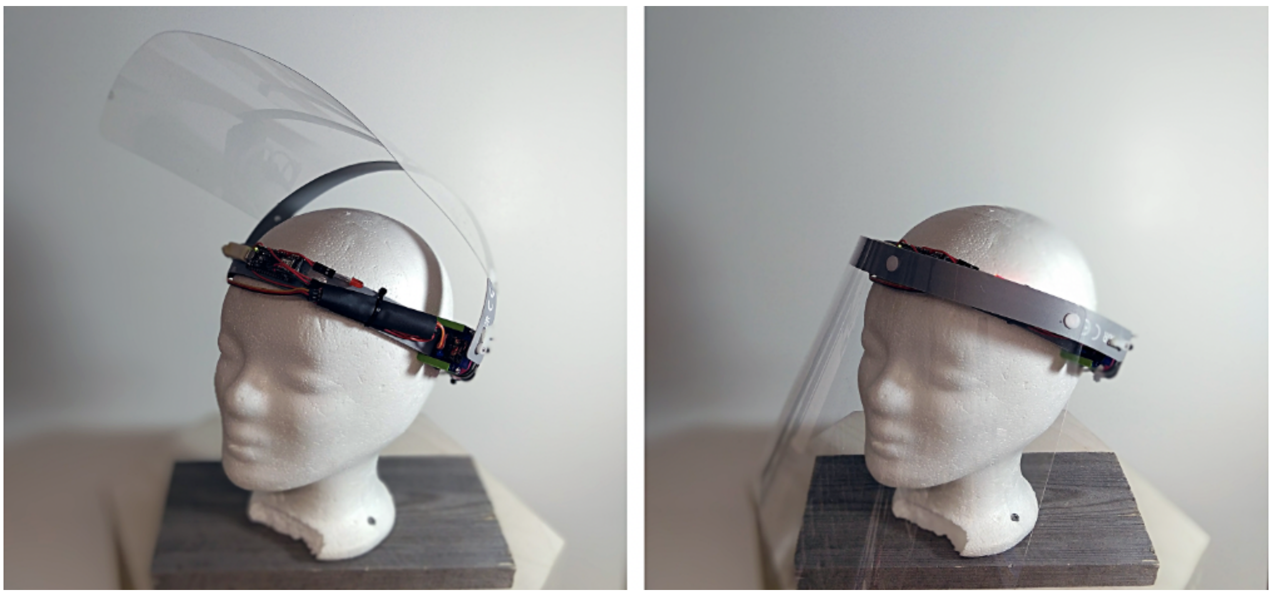

Figure 1: The dynamic face visor in open position (left) and after sensing a cough (right)

ABSTRACT

In this demo, we present a cough activated face visor, where the transparent visor screen moves to cover the wearer's face when coughing sounds are detected. The cough detection is performed by a TinyML machine learning model, running on a microcontroller integrated to the visor's headband. We make no claims regarding the direct impact of our prototype in preventing the spread of Covid-19, but hope it inspires discussion on future smart solutions in the area of personal protective equipment (PPE). Additionally, we note that visibility of the visor's operation potentially encourages observers to adopt preventative measures such as hygiene practices and social distancing.

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CCS CONCEPTS

• **Human-centered computing → Human computer interaction (HCI)**.

KEYWORDS

Cough detection, PPE, face mask, visor, vizor, Covid-19, social distancing

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1 INTRODUCTION AND RELATED WORK

The Covid-19 pandemic rapidly affected everyday life, creating challenges in many sectors in life, ranging from direct health concerns to practicalities caused by social distancing requirements [4, 6]. The pandemic instigated the development of a variety of solutions aimed at preventing the spread of the disease or making early diagnosis. The situation required people to act responsibly and to be considerate of the health and safety of the people surrounding them. On a practical level, actions included hand washing, use of hand sanitizer, following coughing etiquette, the use of face masks and visors and observing social distancing. Solutions focusing on detection have utilized, e.g. IR camera or body worn sensor based detection of elevated body temperature, and analysis of coughing sounds.

Several face mask and visor concepts integrating computational elements have been developed [2, 3, 7]. For example, Tyler Glaiel's face mask, which used an led matrix to simulate mouth movements when speaking [3]. The challenge of occluded facial expressions was also tackled by Genc et al. [2], who displayed facial expressions using electrochromic displays on face masks. Recently, Razer have demonstrated project Hazel, an N95 face mask which is transparent and includes a voice amplifier and inner lighting, so the wearer's mouth can be more easily seen in dim lighting conditions [7]. Whilst most prior work on wearable displays has utilized LEDs or screens as output mechanisms, some works have utilized transforming or shape changing approaches. For example, von Radziewsky et al's transforming scarf [9] and MIT Medialab's lineFORM, the later functioning as both an input and display mechanism [5].

In our demo, we wanted to further explore the possibilities of wearable technology based solutions in promoting protection from spreading the virus in encounters happening in shared physical spaces. As personal protective equipment (PPE) has become an integral part of daily life, wearable technology research should explore possibilities to make it both more effective and less intrusive to wear. As coughing is one occurrence that can spread viruses, we selected it as a context and use case for our design exploration. Our demo presents a face visor which automatically closes when it detects coughing sounds, either from the wearer, or those around them (Figure 1). Sound detection with wearable devices has been earlier successfully explored for context recognition [10]. To identify the sound of coughing, we leveraged the machine learning based cough detection implementation developed by the Edge Impulse team [8], as part of the UN Covid Detect and Protect Challenge. The created TinyML model runs on an Arduino microcontroller integrated to the visor headband and can detect a cough sound in real-time.

We make no claims about the efficacy of our demo in preventing the spread of viruses. However, in initial ad hoc trials, we have identified that the dynamic face visor provides a tangible indication of possible risk to the wearer and people in their vicinity. Through this mechanism, the prototype can potentially influence behavior, e.g. encouraging correct coughing etiquette by covering the mouth.

2 PROTOTYPE

For the prototype, we modified a standard 3M face visor with the addition of two servo motors, a microcontroller (Arduino Nano 33 BLE Sense) and a battery. The selected microcontroller includes an on-board microphone, which was used for capturing audio. The needed mounting hardware for the servo motors was 3D printed (Figure: 2). The cough detection algorithm directly utilized the Tiny ML machine learning based cough detection implementation developed by the Edge Impulse team [8]. As training data, our demo

Figure 2: The dynamic face visor in open and closed positions. An additional LED to indicate when a coughing sound has been recognized is included for development purposes.

implementation utilized the initial dataset provided by Edge Impulse, who note that the model produced based on this data is able to differentiate only between quiet background noise and a small range of coughs. Additional Arduino code used in our implementation was based on code provided by Circuit Digest [1]. When a coughing sound is detected, the visor is set to closed position. When no further coughing is detected within a defined time window, e.g. 1 minute, the visor is reset to the open position.

3 DISCUSSION AND CONCLUSION

Our prototype presents an explorative concept, with the main aim to open discussion and ideation on the area of smart PPE that activates only when required. From our preliminary observations, the concept has a strong secondary function as a physical indicator reminding the wearer and those in the near vicinity to pay attention to practical measures to prevent virus spread. We have also observed a level of surprise in the wearer, when the visor automatically activates. Future work should explore the possibility to design such transformations in a less disruptive manner. Due to the limited training dataset, the performance of the cough recognition model was not ideal, and should be addressed in future works. As next steps we plan to explore cloud based analysis solutions and the integration of motion sensor data.

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